# ENVIRONMENTAL PRODUCT DECLARATION
as per ISO 14025 and EN 15804

<table>
<thead>
<tr>
<th>Owner of the Declaration</th>
<th>IVPU Industrieverband Polyurethan-Hartschaum e.V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programme holder</td>
<td>Institut Bauen und Umwelt e.V. (IBU)</td>
</tr>
<tr>
<td>Publisher</td>
<td>Institut Bauen und Umwelt e.V. (IBU)</td>
</tr>
<tr>
<td>Declaration number</td>
<td>EPD-IVP-20160147-IBE1-DE</td>
</tr>
<tr>
<td>Issue date</td>
<td>02/09/2016</td>
</tr>
<tr>
<td>Valid to</td>
<td>01/09/2021</td>
</tr>
</tbody>
</table>

**PU thermal insulation boards made of block foam**

**IVPU**
Industrieverband
Polyurethan-Hartschaum e.V.

www.ibu-epd.com / https://epd-online.com
1. General Information

IVPU e.V.

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Declaration number
EPD-IVP-20160147-IBE1-DE

This Declaration is based on the Product Category Rules:
Insulating materials made of foam plastics, 07.2014
(PCR tested and approved by the SVR)

Issue date
02/09/2016

Valid to
01/09/2021

Owner of the Declaration
IVPU e.V.
Im Kaisemer 5
D-70191 Stuttgart

Declared product / Declared unit
1 m² of installed PU thermal insulation board made of block foam and a thickness of 12 cm and a thermal conductivity (WLS) of 0.026 W/mK

Scope:
This Environmental Product Declaration applies to polyurethane insulation boards made of block foam as manufactured by the IVPU members Paul Brauder GmbH & Co. KG and puren GmbH. These IVPU members represent the majority of companies within the German polyurethane block foam market. This EPD is based on weighted averages which have been determined on the basis of the single values originating from the factories of the mentioned manufacturing companies (see section 3.1). The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Verification
The CEN Norm /EN 15804/ serves as the core PCR
Independent verification of the declaration according to /ISO 14025/

Prof. Dr.-Ing. Horst J. Bossenmayer
(Chairman of Institit Bauen und Umwelt e.V.)

Dr. Burkhard Lehmann
(Managing Director IBU)

Prof. Dr. Birgit Grahl
(Independent verifier appointed by SVR)

2. Product

2.1 Product description
Polyurethane rigid foam (PU) is a closed-cell foam and factory-made thermal insulating material, which is used in the form of insulation boards in building construction, as well as for insulation of building equipment and industrial installations. The polyurethane insulating material (PU) product family comprises the product variants polyurethane (PUR) and polyisocyanurate (PIR) - see /EN 13165/. PU insulating materials are produced as block foam and insulation boards with flexible facings. This Product Declaration covers PU insulation boards without facings made of block foam. This EPD is based on weighted averages which have been determined on the basis of the single values originating from the factories of the aforementioned manufacturing companies (see section 3.1).

2.2 Application
The scope of application of PU rigid foam insulation materials comprises thermal insulation in building construction (e.g. pitched roofs, flat roofs, floors, ceilings and exterior walls (inside and outside)). Furthermore, PU rigid foam is used for insulating building equipment and industrial installations.

2.3 Technical Data
For determining technical data, testing methods as stated in /DIN 13165/ and /DIN EN 14308/ are used.

Constructional data

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross density</td>
<td>33</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Compressive strength acc. to DIN EN 826/</td>
<td>≥ 100</td>
<td>kPa</td>
</tr>
<tr>
<td>Tensile strength acc. to /DIN EN 1607/</td>
<td>≥ 100</td>
<td>kPa</td>
</tr>
<tr>
<td>Modulus of elasticity acc. to /DIN EN 826/</td>
<td>≥ 4</td>
<td>MPa</td>
</tr>
<tr>
<td>Design value thermal conductivity (Germany)</td>
<td>0.026-0.028</td>
<td>W/(m·K)</td>
</tr>
<tr>
<td>Nominal thermal conductivity acc. to /DIN EN 13165/</td>
<td>0.025-0.027</td>
<td>W/(m·K)</td>
</tr>
</tbody>
</table>
When using the products, the respective national regulations shall apply. In Germany, the requirements for their application in building construction are defined in /DIN 4108-10/. Hygrothermal design values are regulated in /DIN 4108-4/.

2.5 Delivery status
Polyurethane insulation boards made of block foam are manufactured with plane-parallel surfaces or as tapered insulation boards in a thickness range of 20 to 300 mm. This Product Declaration refers to a board thickness of 120 mm. The format of the boards depends on the planned application. The width can be up to 1,250 mm and the length up to 5,000 mm.

2.6 Base materials / Ancillary materials
The PU insulation board made of block foam is 12 cm thick and consists of 3.96 kg/m² PU rigid foam. Polyurethane rigid foam is formed by the chemical reaction of methylene diphenyl disocyanate (MDI, approx. 55-65 %) and polyol (approx. 20-30 %) adding low boiling point blowing agents (approx. 4.6 %). This Product Declaration refers to insulation boards made of block foam that have been foamed using the hydrocarbon pentane. Due to the closed-cell structure, the blowing agent remains within the foam cells. Water (approx. 0.5 %), foam stabilisers and catalysts (approx. 3 %), as well as flame retardants (chlorinated or non-chlorinated phosphoric acid esters, approx. 5 - 10 %) are added as ancillary materials. The raw materials used for the production of polyurethane rigid foams are mainly obtained from crude oil, undergoing several production stages. Polyols can also be produced from renewable raw materials (industrial sugar, glycerin, sorbitol or plant oil).

Polyurethane rigid foam materials meet all relevant requirements regarding the use of certain substances (/Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)/). In accordance with the current REACH candidate list, the foam formulations contain no SVHC substances. Polyurethane rigid foam does not contain volatile isocyanates.

2.7 Manufacture
Polyurethane rigid foam insulation boards made of block foam are produced on block units. In this manufacturing process, the polyurethane reaction mixture pours from a mixing head onto a paper base and foams up to a height of approx. 90 cm. After the cooling phase, the rigid foam blocks are cut to boards with the desired dimensions.

Quality assurance
The declared products as per /DIN EN 13165/ bear the quality mark of the "Überwachungsgemeinschaft Polyurethan-Hartschaum". Quality assurance is based on surveillance and certification by independent Notified Bodies.

2.8 Environment and health during manufacturing
No health protection measures extending beyond the legally-mandated work protection measures for industrial businesses are required during the entire manufacturing process. No special environmental

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water vapour diffusion resistance factor μ</td>
<td>40 - 200</td>
</tr>
<tr>
<td>Creep behaviour or permanent compression strength σ</td>
<td>≥ 20 kPa</td>
</tr>
<tr>
<td>Maximum service temperature T₁</td>
<td>up to + 200 °C</td>
</tr>
<tr>
<td>Minimum service temperature T₂</td>
<td>up to – 200 °C</td>
</tr>
</tbody>
</table>

The gross density of PU insulation boards made of block foam for building construction is approx. 33 kg/m³. For special applications it is possible to manufacture boards with a gross density of up to approx. 200 kg/m³. Depending on their thickness, the boards are manufactured with a gross density of approx. 33 kg/m³ with thermal conductivity levels between WLS 026 and WLS 028 (up to a thermal conductivity level WLS 045 at a gross density of approx. 200 kg/m³). These levels correspond to design values of thermal conductivity between 0.026 and 0.028 W/mK or 0.045 W/mK at high gross density.

Nominal compressive stress or nominal compressive strength at 10 % deformation is at 100 kPa (dh) or 150 kPa (ds) acc. to /DIN 4108-10/. Higher compressive strength up to approx. 3000 kPa is possible.

Nominal tensile strength is 100 kPa. Higher tensile strength is possible.

The water vapour diffusion resistance factor μ of polyurethane rigid foam is between 40 and 200 acc. to /DIN 4108-4/.

Maximum moisture absorption of polyurethane rigid foam at diffusion and condensation is at approx. 6 % by volume. Moisture absorption after freezing and thawing was between 2 % and 7 % by volume.

PU rigid foam products for building equipment and industrial installations can be used in a temperature range from – 200 °C up to + 200 °C.

Polyurethane rigid foam is a distinctive thermosetting material and therefore cannot be melted.

2.4 Application rules

Water vapour diffusion resistance factor μ acc. to /EN 12088/ - 40 - 200 -
Creep behaviour or permanent compression strength σ acc. to /DIN EN 1606/ - ≥ 20 kPa -
Maximum service temperature T₁ acc. to /DIN EN 14706/ - up to + 200 °C -
Minimum service temperature T₂ acc. to /DIN EN 14308/ - Section 4.3.3 - up to – 200 °C -
2.9 Product processing/Installation

Polyurethane rigid foam boards can be cut, sawed, milled, and abraded with conventional construction tools and portable machines. They can be fixed either mechanically or by gluing. It is possible to glue the boards by using either hot-setting or cold-setting adhesives following the manufacturer's recommendations. Alternatively, PU rigid foam boards can be laid loosely, e.g., on floors. Joints between cut PU boards on roof ridges, hips or valleys are to be sealed with polyurethane in-situ foam without thermal bridges. While sawing, abrading, and milling insulation boards, dust is generated. When working on an industrial scale, workers who carry out these processes are to protect themselves by wearing an appropriate dust filter mask (see leaflet of the "Berufsgenossenschaft der Chemischen Industrie" on respiratory protection). Dust concentration in the air (general limit of dust concentration as per /TRGS 900/, Technische Regeln für Gefahrstoffe) must not exceed the following values:
- 10 mg/m³ (measured as inhalable fraction)
- 1.25 mg/m³ (measured as alveolar fraction).
These limits are time-weighted averages assuming an 8-hour exposure per day, 5 days a week, during working lifetime.
Cutting leftovers can be thermally utilised in waste incineration plants or be returned to the manufacturer for recycling.

2.10 Packaging

Primarily plastic foils are used for packaging.

2.11 Condition of use

Under normal conditions of use, the material does not undergo any changes in terms of substance during its service life. Polyurethane is resistant to most chemicals used in construction and does not rot.

2.12 Environment and health during use

The requirements of the Committee for Health-related Evaluation of Building Products (/AgBB/) have been met. Measurements of emissions using testing chambers in accordance with the relevant testing norms (/DIN EN 717-1/ and /DIN (EN) ISO 16000-6, 9 and 11/) showed that volatile organic substances (VOC, VÖ) are emitted in small quantities in the form of the hydrocarbon pentane. Regarding the current REACH candidate list, the foam formulations contain no SVHC substances (see section 2.6).
Polyurethane insulating materials are odourless.

2.13 Reference service life

When used properly, the service life of polyurethane rigid foam corresponds to the service life of the insulated construction components (40 - 50 years, /BNB/). The insulating performance stays the same throughout the entire service life.

2.14 Extraordinary effects

**Fire**

According to national approvals, polyurethane insulating materials made of block foam are classified either as normally ignitable (B2 acc. to /DIN 4102-1/ or E acc. to /DIN EN 13501-1/) or as non-readily ignitable (B1 acc. to / DIN 4102-1/ or C acc. to /DIN EN 13501-1/). In case of fire, PU rigid foam carbonises without dripping off burning droplets and does not tend to smoulder.

When burning, sooty products, water vapour, carbon monoxide, carbon dioxide, nitrogen oxides, as well as traces of hydrogen cyanide are formed. The composition of the smoke gas is the same as with other nitrogen-containing organic substances. The toxicity of the combustion gases mainly depends on the amount of burned material in relation to the size of the room in which the gases are distributed and it also depends on the ventilation conditions in the affected area.

**Water**

Due to the predominant closed-cell structure, insulating materials made of polyurethane rigid foam absorb water only in small quantities. They are not hygroscopic, i.e., they do not absorb water vapour from the air. When unexpectedly exposed to water (e.g., flood), only very small amounts of soluble substances are emitted.

**Mechanical destruction**

If the product is mechanically destroyed, there are no relevant effects on the environment.

2.15 Re-use phase

Dismantling polyurethane insulating materials as well as sorting and waste identifying can be done without difficulties if they are mounted mechanically or laid loosely. Clean and undamaged polyurethane insulation boards can be re-used, re-utilised from material recycling, or recycled as raw material in the production of polyurethane. When re-utilised from material recycling, polyurethane rigid foam waste is used to produce press boards. In this process, cutting and mounting leftovers, as well as construction waste, are mechanically shredded and subsequently pressed into board-shaped products while adding binding agents. PU pressed adhesive boards are a high-quality material which are used to insulate window frames and thermal bridges et al.

2.16 Disposal

According to the /Kreislaufwirtschaftsgesetz/ (Circular Economy Act) and the Regulation on the European List of Waste Materials (/AVV/), polyurethane insulating material shall not be disposed of without prior treatment. The waste disposal code for construction waste is 170604. With thermal treatment, the energy content of the insulating material is recovered.
2.17 Further information
Please visit www.ivpu.de and www.daemmtbesser.de for further information on PU insulating materials.

3. LCA: Calculation rules

3.1 Declared Unit
The declared unit is 1 m² of installed PU thermal insulation board made of block foam and has the following specifications:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared unit</td>
<td>1</td>
<td>m²</td>
</tr>
<tr>
<td>Gross density</td>
<td>33</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Thickness</td>
<td>12</td>
<td>cm</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>0.026</td>
<td>W/(m·K)</td>
</tr>
<tr>
<td>Thermal resistance (R value)</td>
<td>4.6</td>
<td>m²·W/K</td>
</tr>
<tr>
<td>Weight of the declared unit</td>
<td>3.96</td>
<td>kg/m²</td>
</tr>
<tr>
<td>Conversion factor to 1 kg</td>
<td>0.253</td>
<td>m²/kg</td>
</tr>
</tbody>
</table>

The LCA results can be converted linearly for other gross density or board thickness values.

This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the two above-mentioned IVPU members Paul Bauder GmbH & Co. KG and puren GmbH (EPD Class 2a). Energy consumption and the quantity of production waste have been weighted according to the quantities of produced PU rigid foam in m³. Raw material consumption has been weighted according to produced quantities in kg.

3.2 System boundary
Type of EPD: cradle to gate - with options
The life-cycle assessment considers the following modules of the life cycle:
- production and provision of raw materials (A1)
- transporting raw materials (A2)
- production including packaging (A3)
- transport to construction site (A4)
- installation in buildings (recycling or thermal treatment of cutting leftovers and packaging waste) (A5)
- transport to End of Life (C2)
- waste treatment: energy for shredders (C3)
- thermal treatment in waste incineration plants (MVA)
- (C4)
- use potential beyond the system’s boundary due to energy substitution in the MVA (D).

3.3 Estimates and assumptions
For all input, specific GaBi data sets were available. Currently, waste from PU foam production and leftovers from cutting on construction sites can be handled using mainly material recycling (see 2.15). However, using a worst-case approach, in this EPD the incineration and the consequent energy benefit beyond the system boundary shall be considered and be declared in module D.

3.4 Cut-off criteria
In this study, all available data from the production are taken into account, i.e. all used raw materials, used thermal energy, as well as electrical power consumption. Therefore, even materials and power consumption levels that have a share of less than 1% are considered and the cut-off limit of 5% acc. to the PCR Part A is met.

The manufacturers have provided data on transport expenditures for all relevant material flows. Machinery and installations required for the production are neglected.

3.5 Background data
Background data originates from the GaBi software database from thinkstep AG (/GaBi ts 2016D/). The German electrical power mix is used for production while the European power mix is used for the use potentials in module D. The last revision of the used data was less than 6 years ago.

3.6 Data quality
The data used are primary data originating from the industry and were gathered by the IVPU in 2015.2 IVPU members (see above) participated in this data gathering. These IVPU members represent the majority of companies within the German polyurethane block foam market. This EPD is based on weighted averages, which have been determined on the basis of the single values originating from the factories of the aforementioned manufacturing companies. The data’s quality as well as its technological, geographical, and chronological significance can be classified as very good.

3.7 Period under review
The data basis is based on production data from 2015, considering a time span of 12 months.

3.8 Allocation
When thermally treated in waste incineration plants (MVA), recycling as well as use potentials beyond the system boundary for power and thermal energy in module D are taken into account in an input-specific manner considering elemental composition as well as calorific values. Due to distribution throughout all of Europe, the substitution processes in module D refer to the reference area of Europe (EU-27).
3.9 Comparability
Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account. The used background database has to be mentioned.

4. LCA: Scenarios and additional technical information

The following technical information serves as the basis for the declared modules. If modules are not declared (MND), it may also be used for developing specific scenarios in the context of a building assessment.

<table>
<thead>
<tr>
<th>Transport to construction site (A4)</th>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litres of fuel</td>
<td>159</td>
<td>l/100km</td>
<td></td>
</tr>
<tr>
<td>Transport distance</td>
<td>500</td>
<td>km</td>
<td></td>
</tr>
<tr>
<td>Capacity utilisation (including empty runs)</td>
<td>85</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Gross density of products transported</td>
<td>33</td>
<td>kg/m³</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installation in buildings (A5)</th>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materia loss</td>
<td>5</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Packaging waste</td>
<td>0.04</td>
<td>kg</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End of life cycle (C1-C4)</th>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuse</td>
<td>0</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Energy recovery</td>
<td>396</td>
<td>kg</td>
<td></td>
</tr>
<tr>
<td>Landfilling</td>
<td>0</td>
<td>kg</td>
<td></td>
</tr>
</tbody>
</table>

Reuse, recovery, and recycling potentials (D), relevant scenario data
100 % thermal treatment in an MVA.
5. LCA: Results

### RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² of installed PU insulation board made of block foam

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1-A3</th>
<th>A4</th>
<th>A5</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWP</td>
<td>[kg CO₂-Eq.]</td>
<td>1.48E+1</td>
<td>2.96E-1</td>
<td>5.40E-1</td>
<td>5.72E-2</td>
<td>1.02E-1</td>
<td>8.74E+0</td>
<td>-4.00E+0</td>
</tr>
<tr>
<td>ODP</td>
<td>[kg CFC11-Eq.]</td>
<td>2.34E-6</td>
<td>1.32E-12</td>
<td>4.00E-7</td>
<td>2.62E-13</td>
<td>7.25E-11</td>
<td>2.56E-11</td>
<td>-1.26E-9</td>
</tr>
<tr>
<td>AP</td>
<td>[kg SO₂-Eq.]</td>
<td>3.00E-2</td>
<td>1.64E-3</td>
<td>6.18E-4</td>
<td>3.24E-4</td>
<td>2.84E-4</td>
<td>3.51E-3</td>
<td>-8.26E-3</td>
</tr>
<tr>
<td>EP</td>
<td>[kg PO₄-Eq.]</td>
<td>4.90E-3</td>
<td>4.09E-4</td>
<td>1.08E-4</td>
<td>4.09E-5</td>
<td>2.54E-5</td>
<td>8.91E-4</td>
<td>-6.37E-4</td>
</tr>
<tr>
<td>POCP</td>
<td>[kg ethylene-Cl]</td>
<td>1.90E-6</td>
<td>-6.73E-4</td>
<td>2.12E-4</td>
<td>-1.33E-4</td>
<td>1.96E-5</td>
<td>2.96E-4</td>
<td>-6.72E-4</td>
</tr>
<tr>
<td>ADPE</td>
<td>[kg Sb-Eq.]</td>
<td>2.88E-5</td>
<td>1.02E-8</td>
<td>4.86E-7</td>
<td>3.00E-9</td>
<td>3.34E-8</td>
<td>6.87E-8</td>
<td>-6.71E-7</td>
</tr>
<tr>
<td>ADPF</td>
<td>[MJ]</td>
<td>3.06E+2</td>
<td>3.97E+0</td>
<td>5.24E+0</td>
<td>7.85E-1</td>
<td>1.11E+0</td>
<td>2.07E+0</td>
<td>-5.52E+1</td>
</tr>
</tbody>
</table>

Caption: GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone precursor oxides; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources

### RESULTS OF THE LCA - RESOURCE USE: 1 m² of installed PU insulation board made of block foam

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1-A3</th>
<th>A4</th>
<th>A5</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERE</td>
<td>[MJ]</td>
<td>1.63E+1</td>
<td>2.36E-1</td>
<td>2.36E-1</td>
<td>4.46E-2</td>
<td>4.98E-1</td>
<td>2.27E-1</td>
<td>-8.67E+0</td>
</tr>
<tr>
<td>PERM</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>PERT</td>
<td>[MJ]</td>
<td>1.63E+1</td>
<td>2.36E-1</td>
<td>2.36E-1</td>
<td>4.46E-2</td>
<td>4.98E-1</td>
<td>2.27E-1</td>
<td>-8.67E+0</td>
</tr>
<tr>
<td>PENRE</td>
<td>[MJ]</td>
<td>2.26E+2</td>
<td>3.98E+0</td>
<td>5.56E+0</td>
<td>7.88E-1</td>
<td>1.78E+0</td>
<td>2.33E+0</td>
<td>-8.72E+1</td>
</tr>
<tr>
<td>PENRM</td>
<td>[MJ]</td>
<td>9.90E+1</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>PENRT</td>
<td>[MJ]</td>
<td>3.25E+2</td>
<td>3.98E+0</td>
<td>5.56E+0</td>
<td>7.88E-1</td>
<td>1.78E+0</td>
<td>2.33E+0</td>
<td>-8.72E+1</td>
</tr>
<tr>
<td>SM</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>RSF</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>NRSF</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>FW</td>
<td>[MJ]</td>
<td>9.47E-2</td>
<td>5.66E-4</td>
<td>2.23E-3</td>
<td>1.12E-4</td>
<td>7.69E-4</td>
<td>2.02E-2</td>
<td>-1.38E+0</td>
</tr>
</tbody>
</table>

Caption: PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of renewable primary energy excluding non-renewable primary energy resources; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

### RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² of installed PU insulation board made of block foam

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1-A3</th>
<th>A4</th>
<th>A5</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWD</td>
<td>[kg]</td>
<td>1.48E-5</td>
<td>3.01E-7</td>
<td>2.55E-7</td>
<td>5.96E-8</td>
<td>1.13E-9</td>
<td>1.30E-9</td>
<td>-2.56E-8</td>
</tr>
<tr>
<td>NHWD</td>
<td>[kg]</td>
<td>3.20E-1</td>
<td>3.35E-4</td>
<td>4.54E-3</td>
<td>6.62E-5</td>
<td>1.07E-3</td>
<td>8.92E-3</td>
<td>-2.53E-2</td>
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<tr>
<td>RWD</td>
<td>[kg]</td>
<td>7.86E-3</td>
<td>5.66E-4</td>
<td>1.30E-4</td>
<td>1.13E-6</td>
<td>2.96E-4</td>
<td>1.96E-4</td>
<td>-4.78E-3</td>
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<tr>
<td>CRU</td>
<td>[kg]</td>
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<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>MFR</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
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</tr>
<tr>
<td>MER</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>EEE</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>1.16E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>3.02E+1</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>EET</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>1.16E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>3.02E+1</td>
<td>0.00E+0</td>
</tr>
</tbody>
</table>

Caption: HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy

6. LCA: Interpretation

Modules A1-A3: Impacts on the environment of the production stage are mainly determined by raw material production and processing in A1. In all impact categories, upstream processes prior to the production of isocyanate have significant effects, especially in the depletion potential of the stratospheric ozone layer (ODP, Ozon Depletion Potential). However, some effects can also be attributed to the upstream processes in the production of polyol and to a small extent to the use of flame retardants. For example within the impact category Global Warming Potential (GWP), isocyanate has a significant
effect (approx. 50 %) while polyols and flame retardants only have a moderate share in the overall result (approx. 10 %, respectively).

Non-renewable primary energy consumption (PENRE) can mainly be attributed to the upstream processes within the production of isocyanate and polyol (approx. 70 % in total).

Module C4: The environmental load in C4 is caused by the combustion of the PU insulation board.

Module D: The utilisation potential for the next product system originates from substituting primary energy for the generation of power and steam in MVAs that thermally treat the PU insulation boards.

7. Requisite evidence

7.1 VOC emissions
Emission tests on PU boards made of block foam found that the VOC values are significantly below the limits determined by the AgBB scheme /PU Europe Technical Dossier/. The tests were conducted by the research organisations Eurofins/Denmark, VTT/Finland and /WKI/Germany, among others.

VOC emissions

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of Results (28 Tage)</td>
<td>-</td>
<td>µg/m³</td>
</tr>
<tr>
<td>TVOC (C5 - C16)</td>
<td>0 - 100</td>
<td>µg/m³</td>
</tr>
<tr>
<td>Sum SVOC (C16 - C22)</td>
<td>0 - 10</td>
<td>µg/m³</td>
</tr>
<tr>
<td>R (dimensionless)</td>
<td>0 - 5</td>
<td>-</td>
</tr>
<tr>
<td>VOC without NIK</td>
<td>0 - 100</td>
<td>µg/m³</td>
</tr>
<tr>
<td>Carcinogenic Substances</td>
<td>0</td>
<td>µg/m³</td>
</tr>
</tbody>
</table>

7.2 Isocyanate emission
In the analysis conducted by the Fraunhofer Institut für Holzforschung, Wilhelm-Klauditz-Institut /WKI (1998), no isocyanate emission could be detected in the 1-m³ test chamber. SUPELCO cartridges have been used for detecting MDI. The detection limit is at 10 ng/m³.

7.3 Formaldehyde
Emission tests on PU boards made of block foam only detected very small quantities of formaldehydes < 3 µg/m³ (/PU Europe Technical Dossier/ and /Eurofins Test Report/). This is significantly below the threshold value of 120 µg/m³ (Class E1).

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Institut Bauen und Umwelt e.V., Berlin (pub.): Generation of Environmental Product Declarations (EPDs);
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GaBi ts

GaBi ts documentation

Further references:
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AVV

BNB
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DIN 4108-4
DIN 4108-10

DIN CEN/TS 14405

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DIN EN 1606
DIN EN 1606:2013-05, Thermal insulating products for building applications - Determination of compressive creep; German version EN 1606:2013

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DIN EN 12457-3
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DIN EN 13501-1

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DIN EN 14706
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DIN EN 717-1

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IVPU

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**WKI**